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Abstracts

Physical properties of cartilage extracellular matrix

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Cartilage is a composite material composed of relatively small number of cells (chondrocytes) surrounded by the extracellular matrix (ECM). Approximately 70 to 85% of the weight of the tissue is water. The major macromolecular components of the ECM are proteoglycans (PGs) and collagen. Approximately 30 to 35 % of the dry weight of cartilage tissue is composed of PGs., which bind to hyaluronic acid chains forming large aggregates. Collagen is a fibrous protein that makes up 65 to 70 % of the dry weight of the tissue. Type II is the dominant collagen in cartilage, but other types of collagen are also present. Collagen architecture varies with the depth from the articular surface. PG concentration and water content also vary with the depth. Near the articular surface the PG concentration is relatively low, while in this region the water content is high. In deeper regions, the PG concentration is greater, and the water content becomes lower.
We studied the physical and chemical properties of cartilage and its polymeric constituents using a number of complementary methods (e.g., osmometry, atomic force microscopy, scattering methods). Combination of these techniques provides insight in the relationship between microstructure and mechanical properties. Our model cartilage was engineered from chondrocytes harvested from chick embryo sternum and cultured on poly(vinyl alcohol) hydrogel scaffolds. Osmotic swelling pressure was measured at different stages of tissue development using a tissue micro-osmometer. Atomic force microscopy was used in tandem to map the local mechanical properties. The concentration of the main biopolymer components was determined by biochemical analysis. The results, which shed light on the role played by the major polymeric constituents of the ECM in cartilage biomechanics and osmotic properties, are discussed.